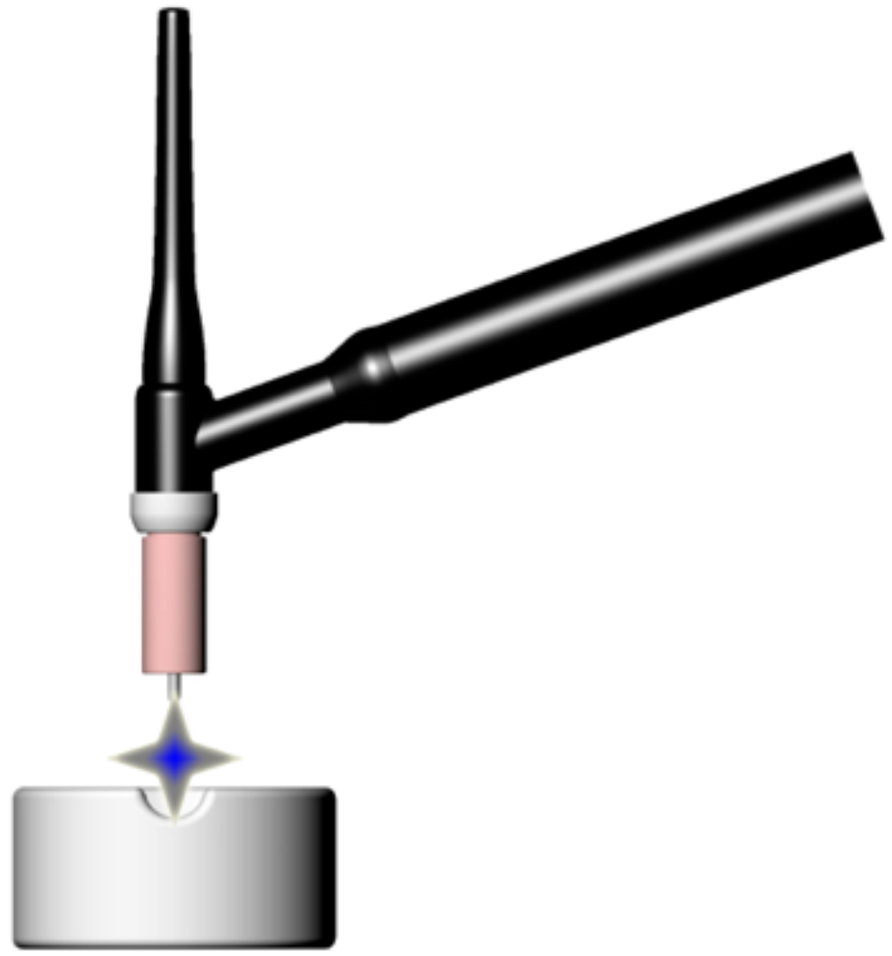
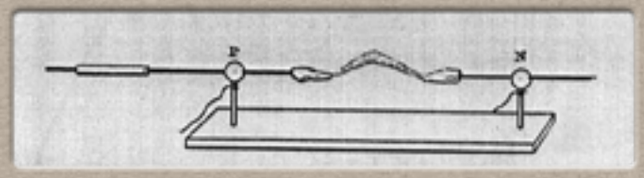


DC ARC MELTING FOR STUDIO JEWELRY CASTING

DC ARC MELTING HISTORY
DISCOVERY OF THE ARC

Sir Humphrey Davy

- Discovered the electric arc in 1801
- Melted metals and other materials in the arc 1810-1811.

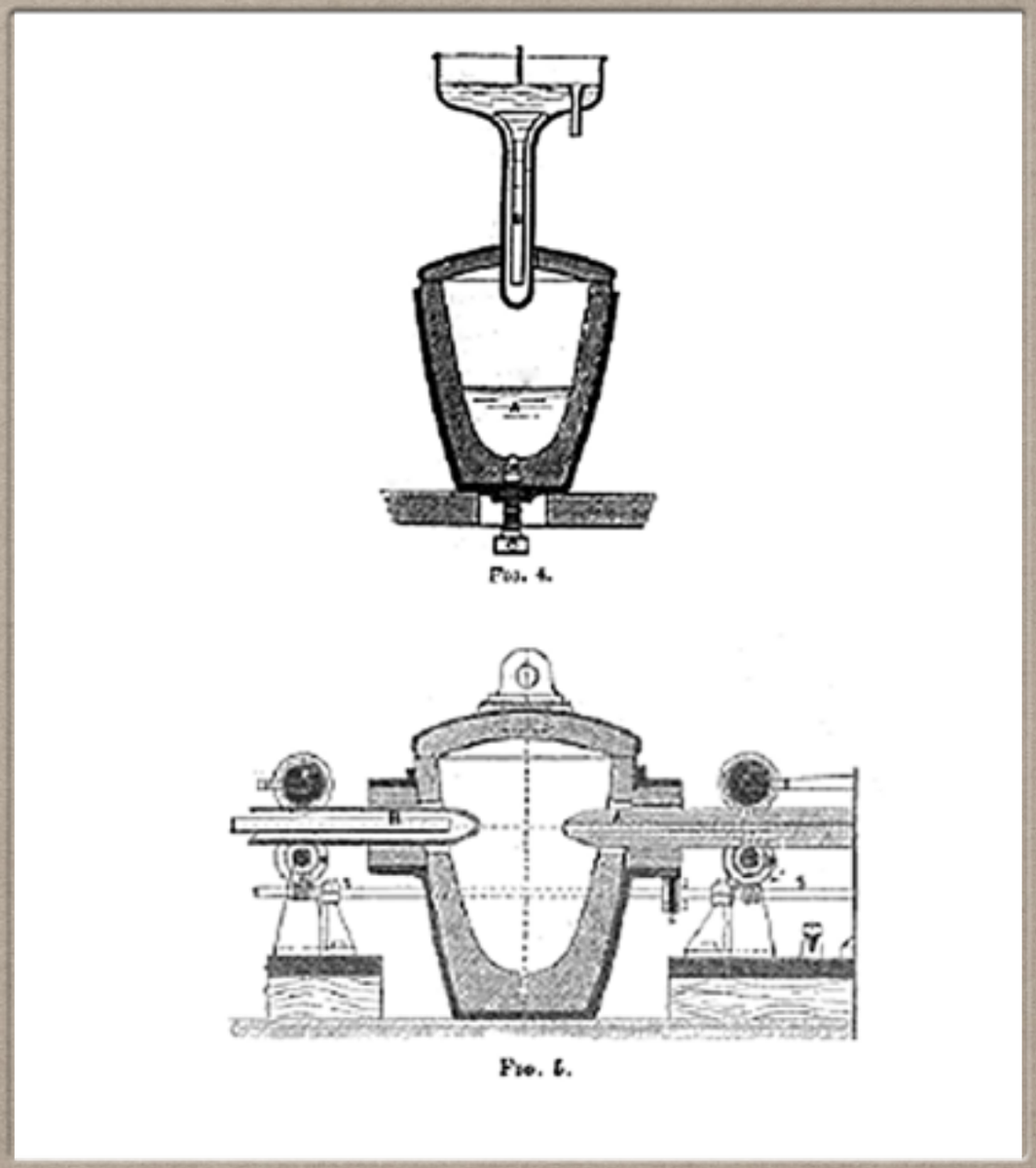


Vasily Vladimirovich Petrov

- Rediscovered? the electric arc 1802
- Proposed the concept of arc

DC ARC MELTING HISTORY
SIR WILIAM SIEMENS

- Patented the arc melting furnace in 1878-79
- Reported on his demonstration furnace to the British Association for the Advancement of Science meeting in 1882



Patent Drawings

AC ARC MELTING TAKES OVER

- Héroult patented the AC arc furnace for steel production in 1900
- Due to the ease of providing large quantities of AC power AC furnaces replaced the DC furnace in large scale use for more than 90 years.
- Recent advances in power semiconductors have allowed a resurgence in large industrial DC furnaces.

Paul Héroult

ARC MELTING IS THE STANDARD METHOD FOR LARGE SCALE METAL MELTING

WHY NOT SMALL SCALE?

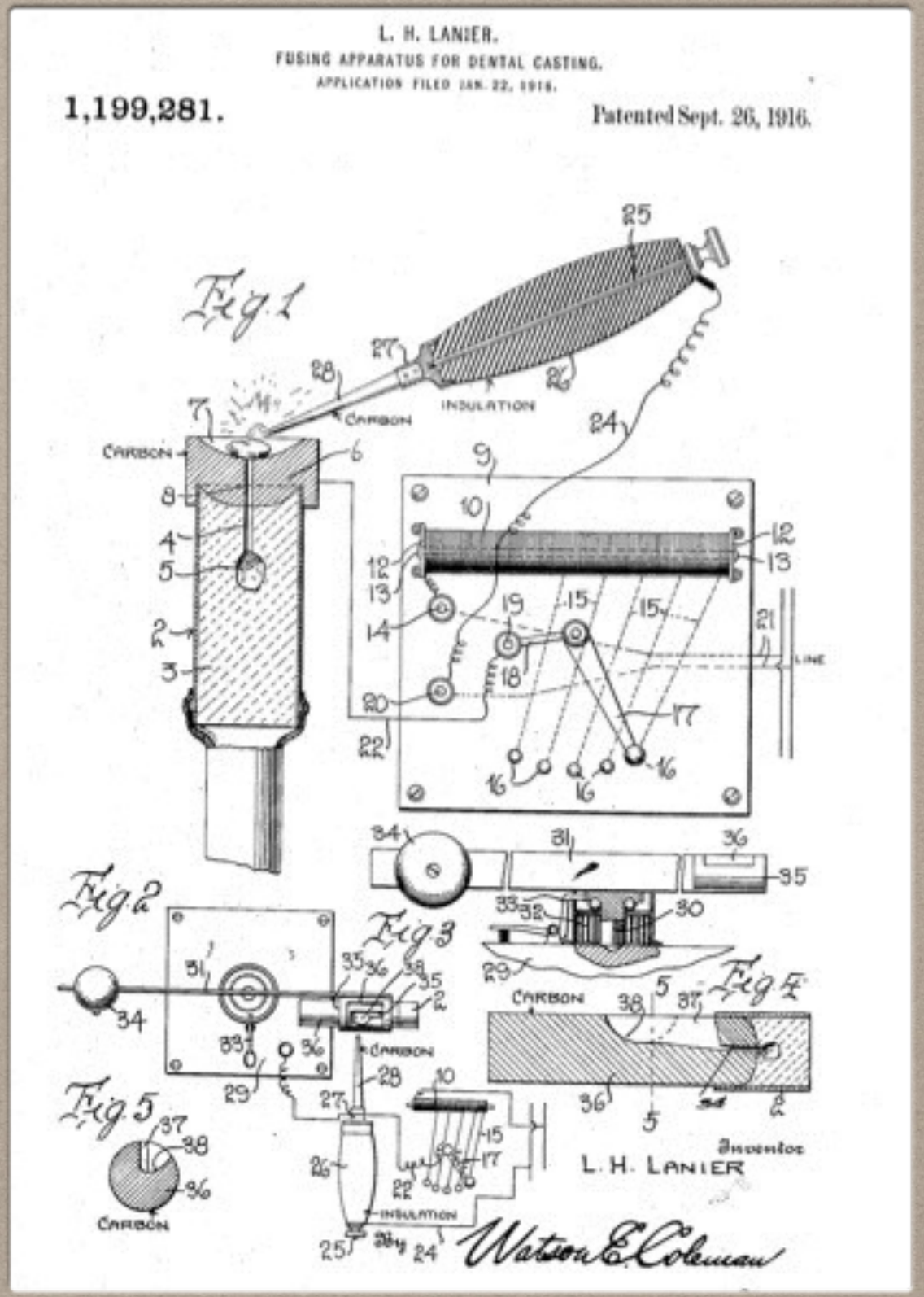
ARC MELTING PROJECT

- This project grew out of my desire to melt and cast small amounts of metal in my studio a clean, oxygen-free environment.
- The use of a TIG torch seemed to be a possible way to do this

ARC MELTING FOR INVESTMENT CASTING

1916 US PATENT

- Proposed arc melting of metal for investment casting via vacuum assisted or centrifugal methods


L. H. LANIER.
FUSING APPARATUS FOR DENTAL CASTING.
APPLICATION FILED JAN. 22, 1916.

1,199,281. Patented Sept. 26, 1916.

Fig. 1

CARBON
INSULATION
CARBON

Fig. 2

Fig. 3

Fig. 4

Fig. 5

CARBON

Inventor
L. H. LANIER

Watson E. Coleman

CURRENT SMALL SCALE DC ARC MELTING

- DC arc melting continues to be used for small scale laboratory and speciality furnaces
- These furnaces typically use a water-cooled copper crucible or hearth plate to limit contamination from refractory materials
- They provide vacuum or inert atmospheres around the melt

Cianflone Model 2701X arc button re-melt furnace

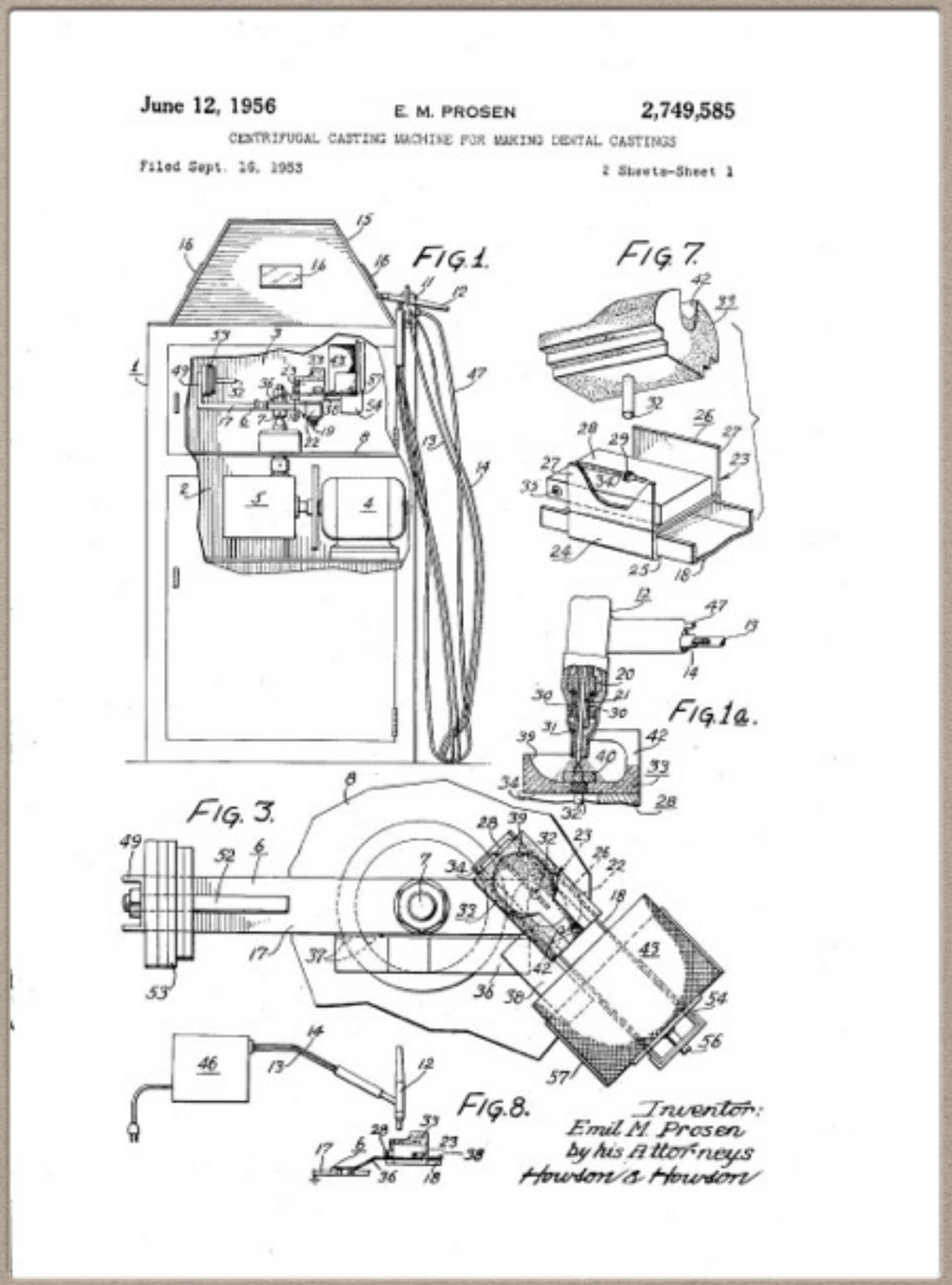
SMALL SCALE ARC MELT INVESTMENT CASTING

- There are also a few investment casting machines using arc melting for jewelry,dental or other small objects
- They use either graphite or water-cooled copper crucibles to melt in.
- Utilizing pressure over vacuum or centrifugal casting methods.

ARC MELTING FOR INVESTMENT CASTING

1956 US PATENT

- Crucible with conductive metal pin
- TIG torch suppling the arc


June 12, 1956 E. M. PROSEN 2,749,585

CENTRIFUGAL CASTING MACHINE FOR MAKING DENTAL CASTINGS

Filed Sept. 16, 1953 2 Sheets-Sheet 1

FIG. 1.

FIG. 7.

FIG. 1a.

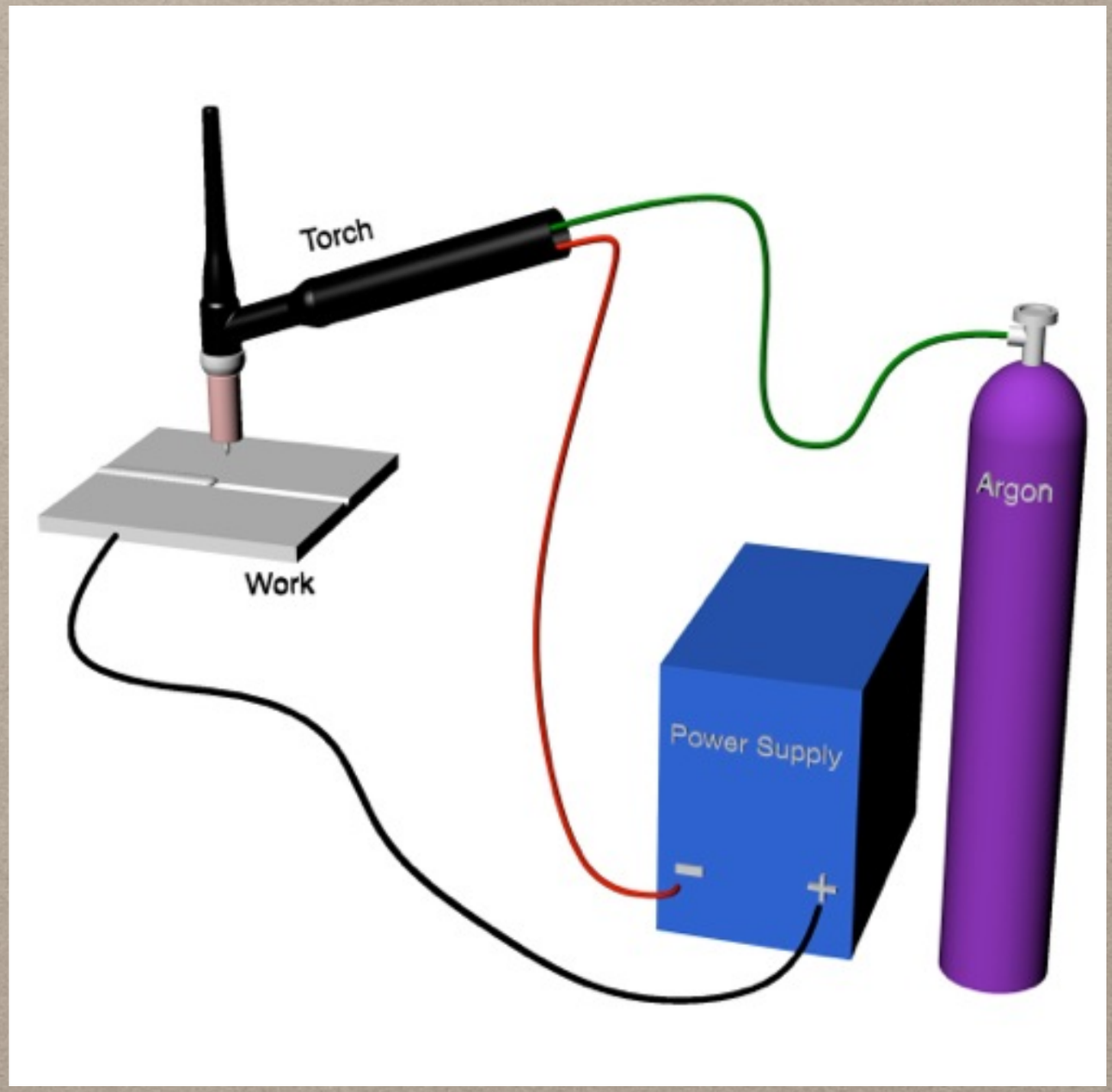
FIG. 3.

FIG. 8.

Inventor:
Emil M Prosen
by his Attorneys
Howson & Howson

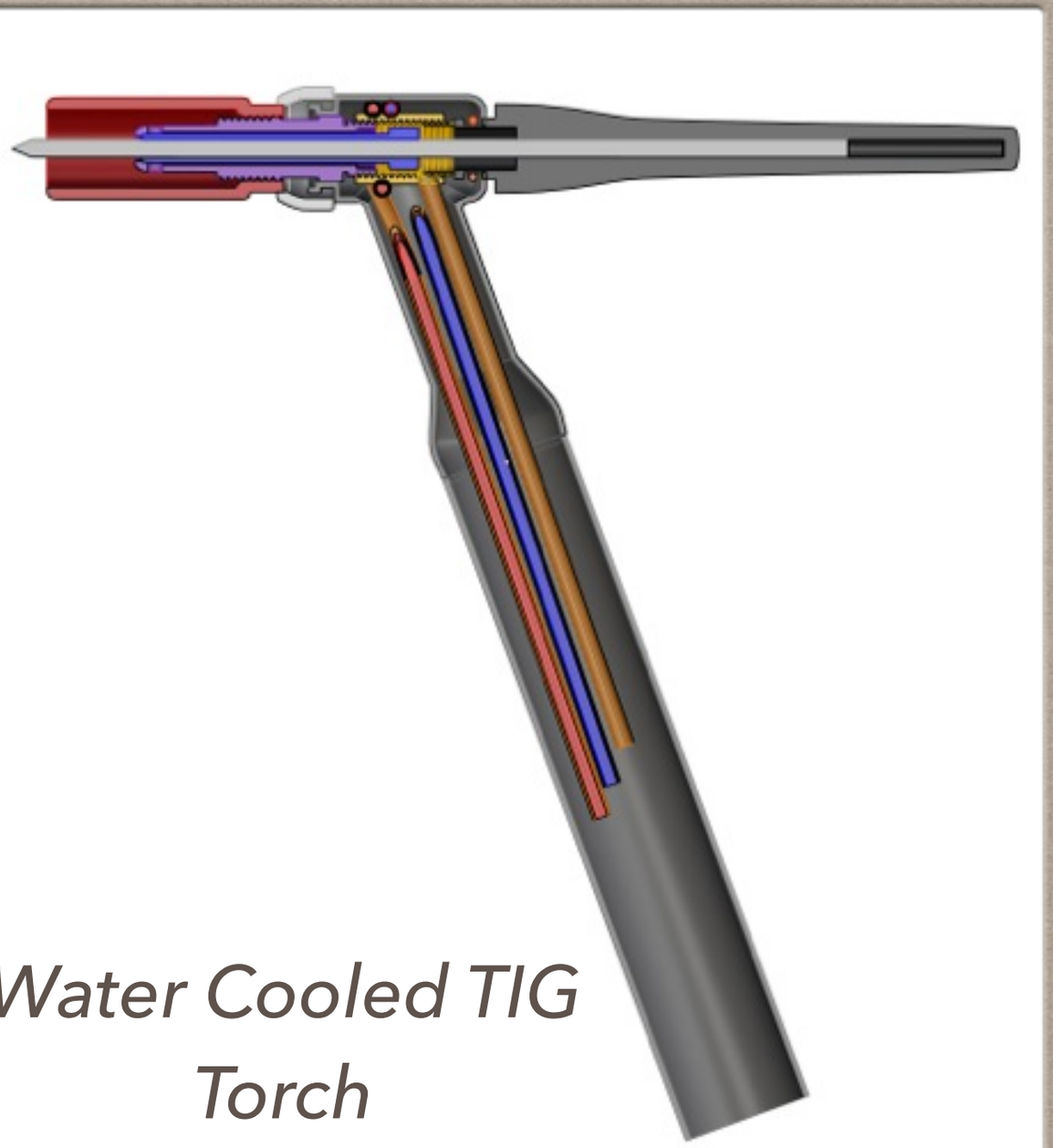
TUNGSTEN INERT GAS WELDING

- Also known as GTAW Gas Assisted Tungsten Arc Welding
- A non consumable tungsten electrode is used to strike an arc to the work
- The heat of the arc creates a molten puddle to fuse the metal



TIG TORCH

- Can either be air or water cooled
- Collet assembly to firmly clamp tungsten for electrical and thermal conductivity
- Gas channels around collet cool the tungsten and provide inert atmosphere shielding for the weld



Water Cooled TIG Torch

130 AMP POWER SUPPLY

- Advances in power semiconductors have made small power supplies very affordable

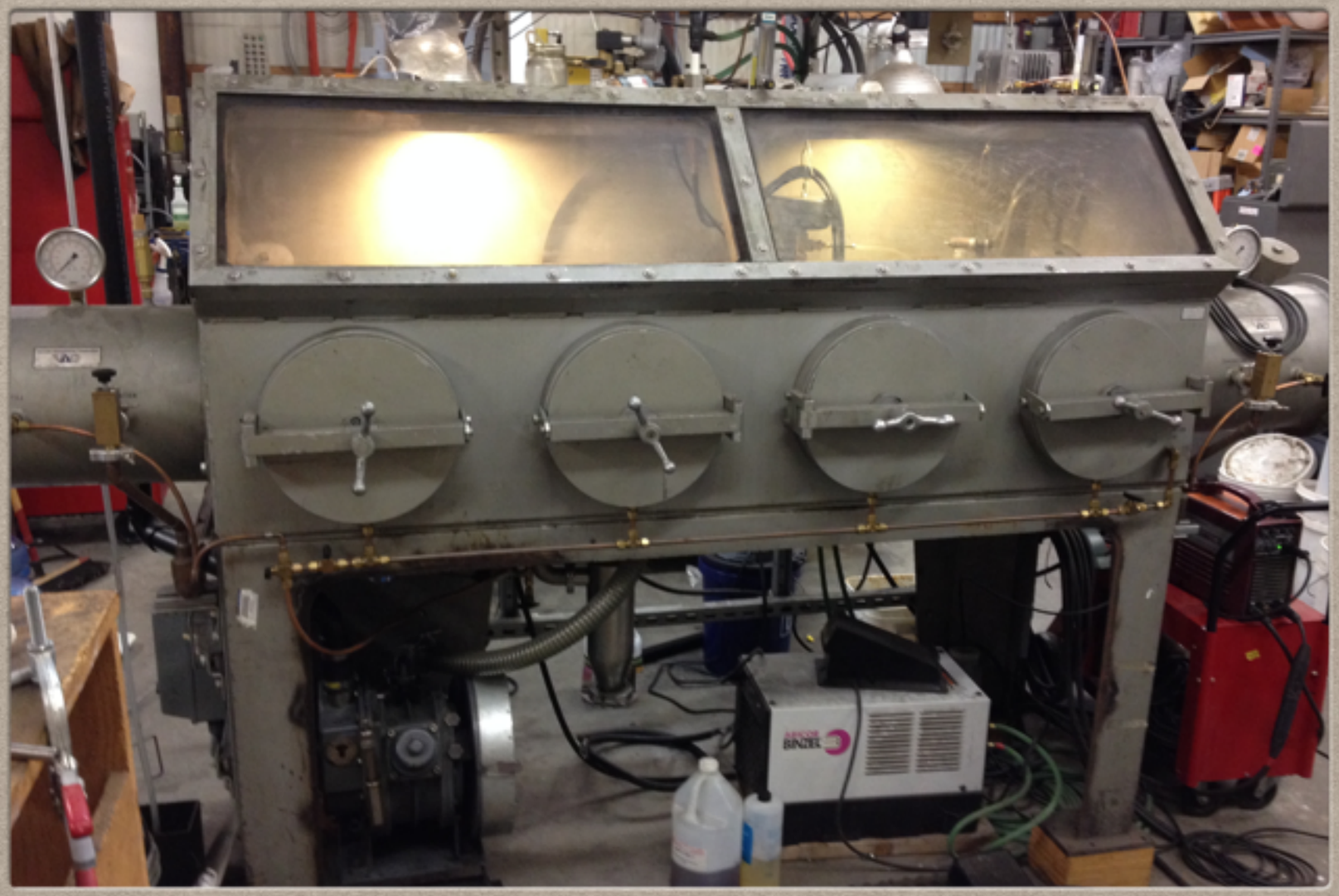
INITIAL ATTEMPTS

- Using a graphite hearth had mixed results, some alloys worked well others were very oxidized
  - Oxidation from turbulence in inert gas stream
  - Thermal losses to graphite crucible and copper plate

GAS LENS VS STANDARD COLLET BODY

- The gas lens was invented to reduce turbulence in shielding gas stream
- Even with the laminar flow turbulence is still an issue in the crucible
- What is the answer?

A CONTROLLED ATMOSPHERE CHAMBER



VACUUM PURGED GLOVE BOX

- Vacuum purged below 26pa and backfilled with argon.
- Chamber O2 levels below 0.1ppm easy to achieve
- Airlocks to bring items in and out of the chamber

Glove Ports Open

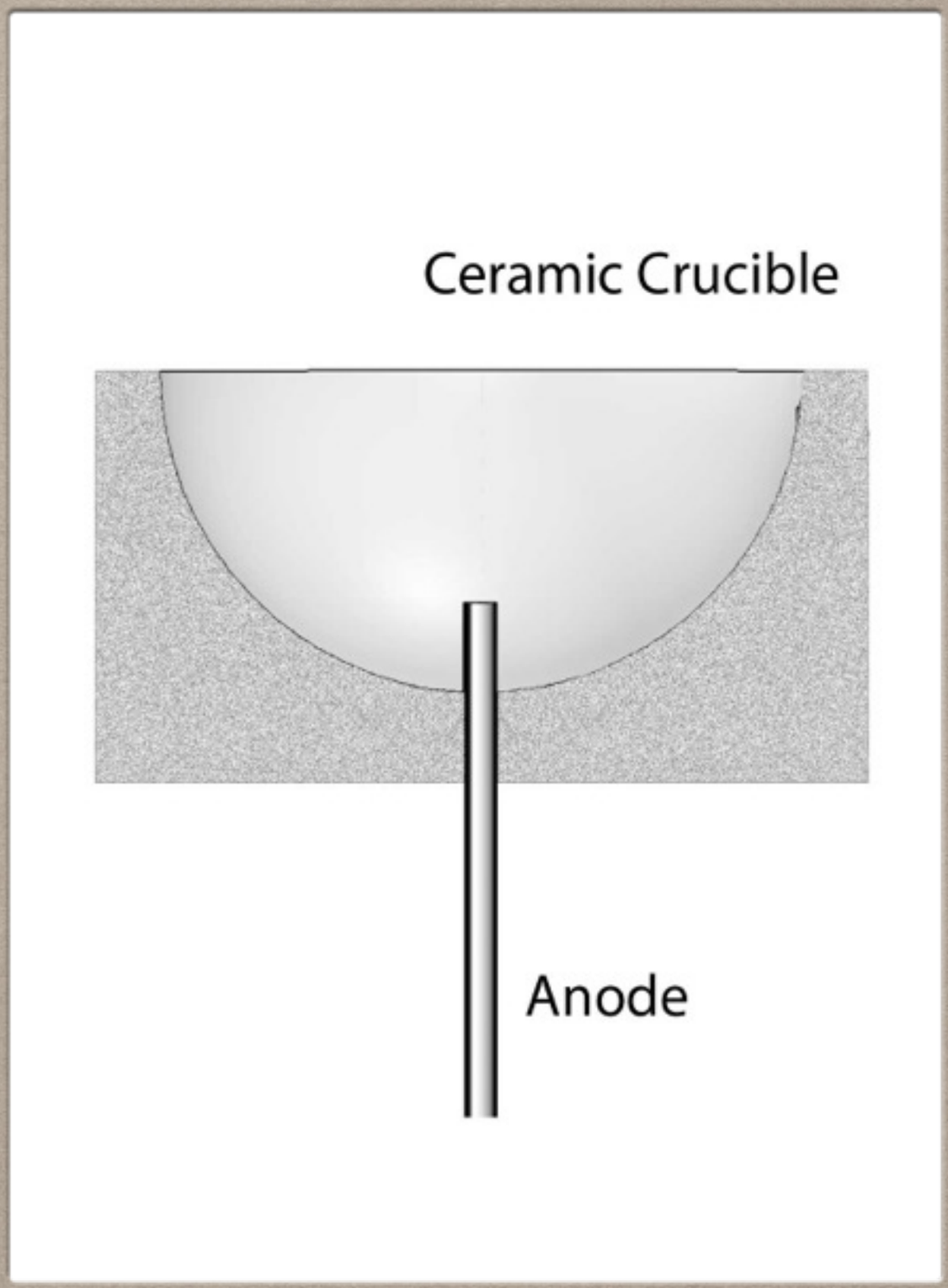

MILLITORR


PHOTOHELIC
Dwyer

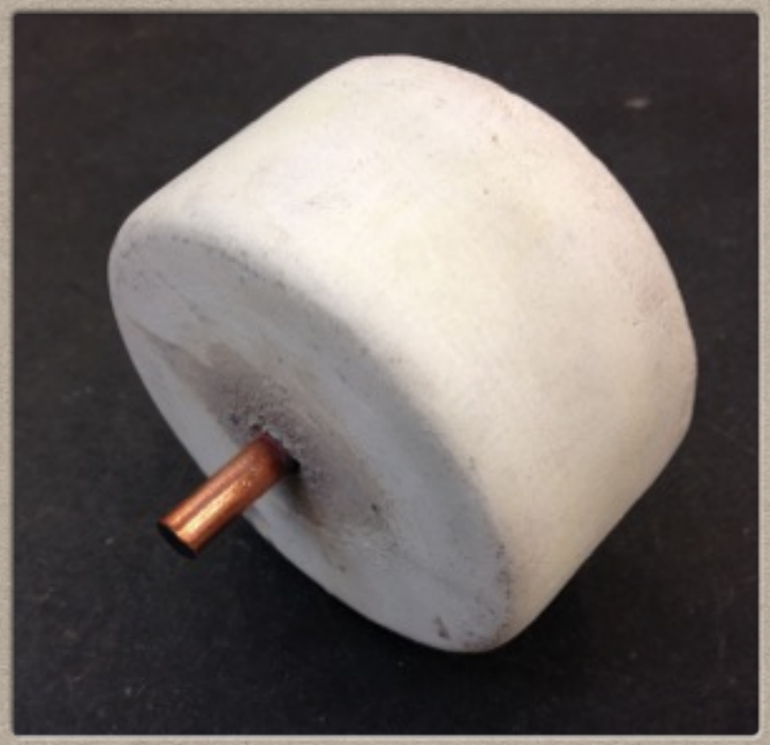
INTERNAL WORKSPACE

CRUCIBLE & ELECTRODE

The concept of the crucible with a conductive rod in the base dates back to Siemens original patent



GRAPHITE ELECTRODE



- Copper sheathed graphite rod
- Reaction with crucible from secondary arc.

TUNGSTEN ELECTRODE

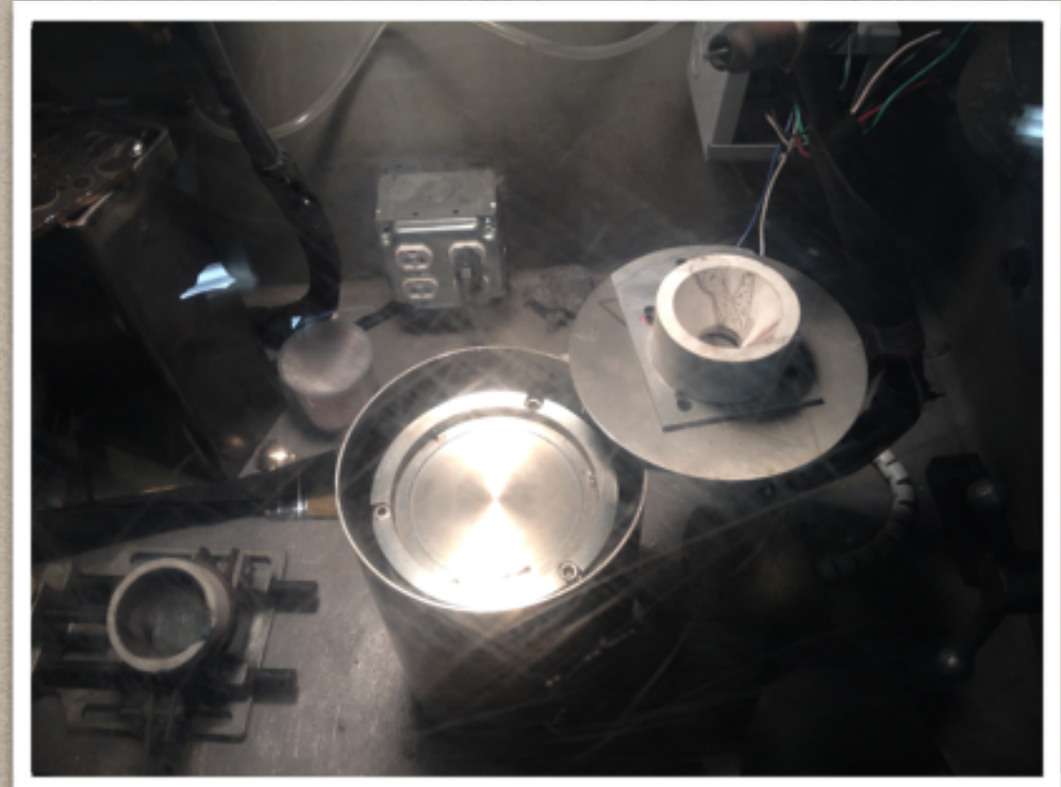
- Provides electrical contact to metal for melting.
- Works best with lower melting point metals (below 2000F)

WATER COOLED ELECTRODE

- Uses a modified TIG torch to hold the electrode.
- Allows the use of tungsten or consumable electrodes made from the same metal as is being melted.

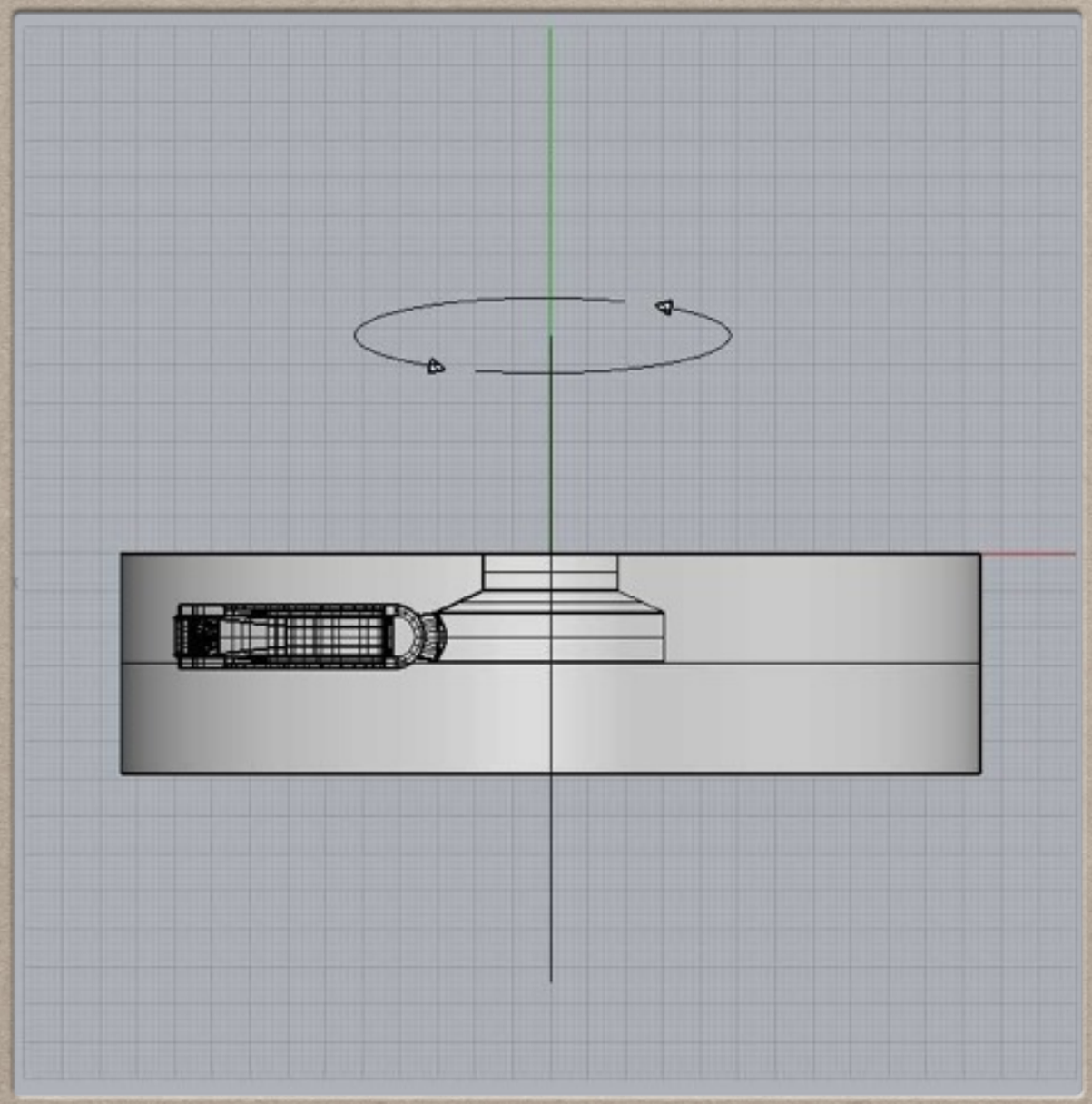
CONSUMABLE ELECTRODE

- Like the tungsten electrode it provides electrical contact to metal for melting.
- Eliminates the possible contamination of the melt by tungsten

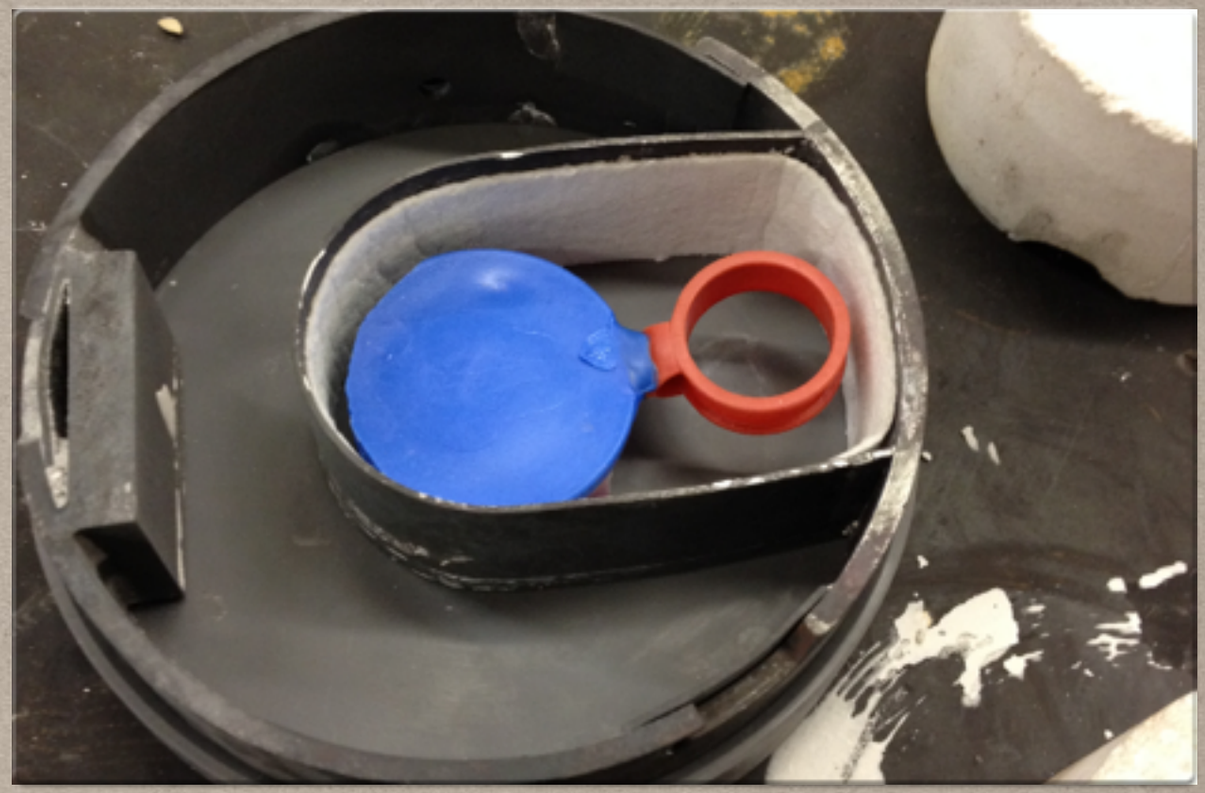


TI RESEARCH-CAST/T MACHINE

CASTING FLASK



Flask spins on central axis
@ 930 RPM



ARC MELTING AND CASTING PD950

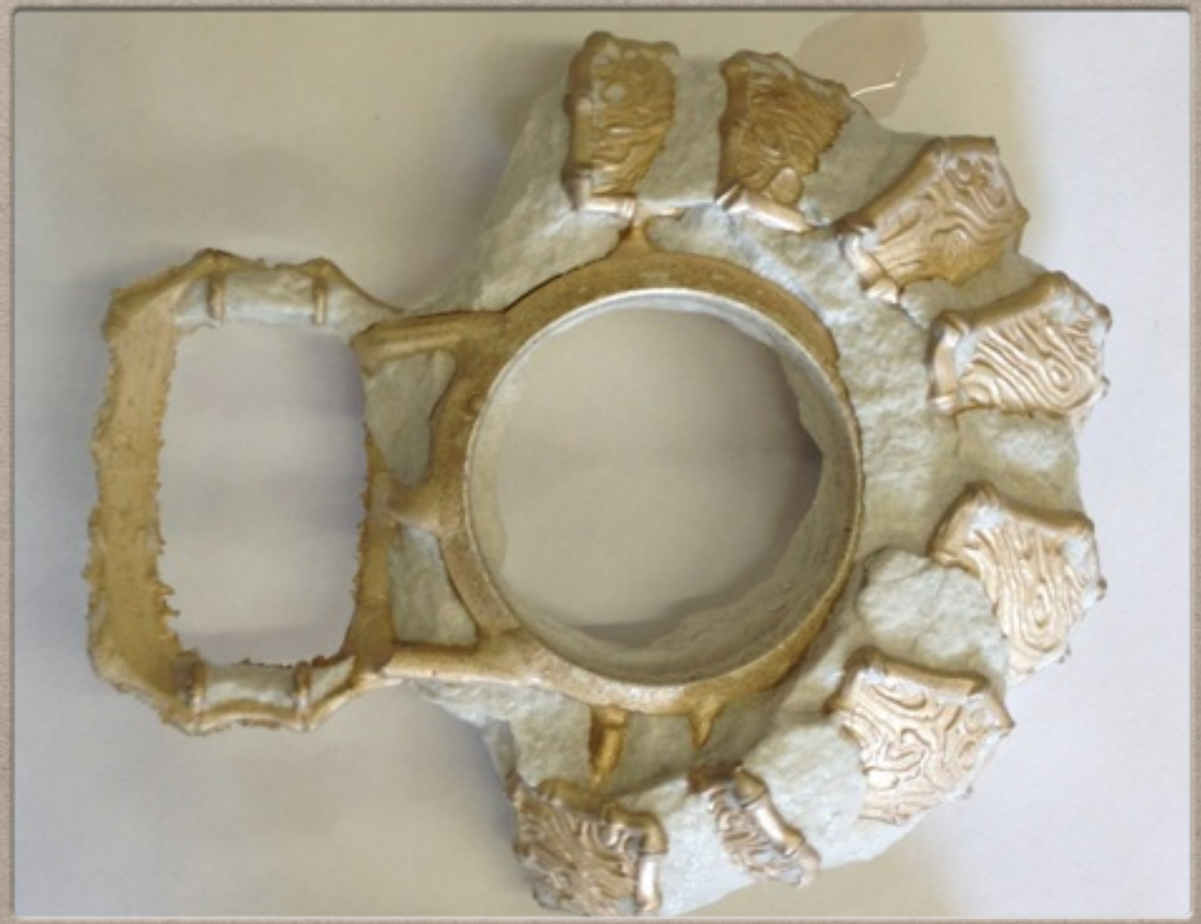
https://www.youtube.com/watch?v=ya5wJFcd2DU&feature=youtu.be

TUNGSTEN ELECTRODE

316 STAINLESS

https://www.youtube.com/watch?v=TwsxZqfa2ew&feature=youtu.be

CONSUMABLE ELECTRODE MELT



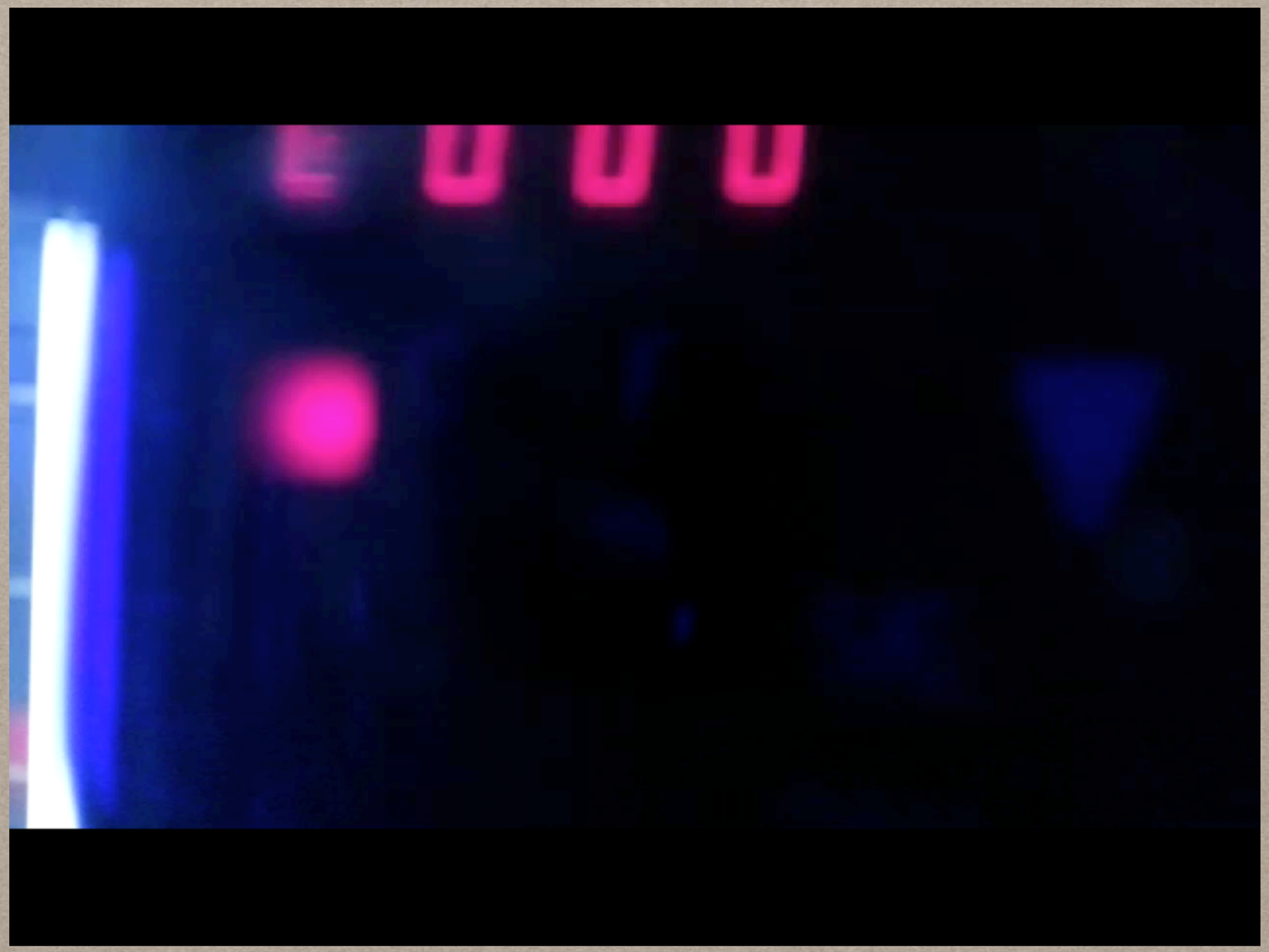
METALS SUCCESSFULLY MELTED AND CAST

- Palladium 950 T (some issues with contamination silica? tungsten? both?)
- Sterling Silver T, C
- 18K Yellow T
- 14K Red, 14K Palladium White T
- Copper T, C
- 316 Stainless Steel T, C

T= Tungsten C=Consumable

COMPARISON WITH INDUCTION

INDUCTION MELT 316 STAINLESS

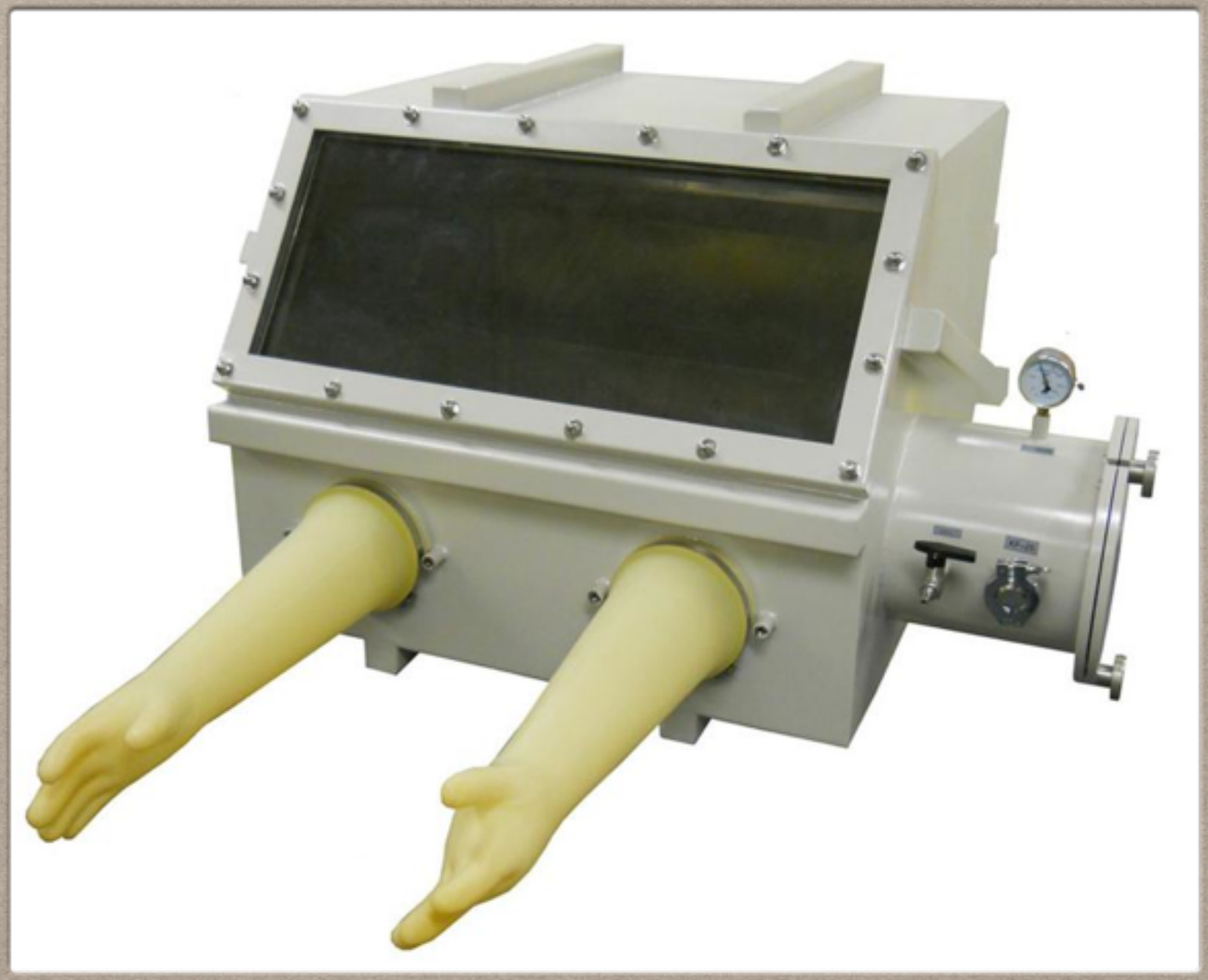


	Power	Time to melt	Cost
DC Arc	3.6 kW 20 Amp 220 Single Phase	34 Sec	$7K to $10K
Induction	5kW Out 50 Amp 220 3Phase	20 sec	$15K-$50K

POSSIBLE ARC MELT/CAST CONFIGURATIONS

VACUUM PURGED GLOVEBOX

- Chamber purged by vacuum and backfill with inert gas
- Low gas usage
- Vacuum air lock to move flasks in and out.
- Have to work with gloves



GAS PURGED GLOVE BOX

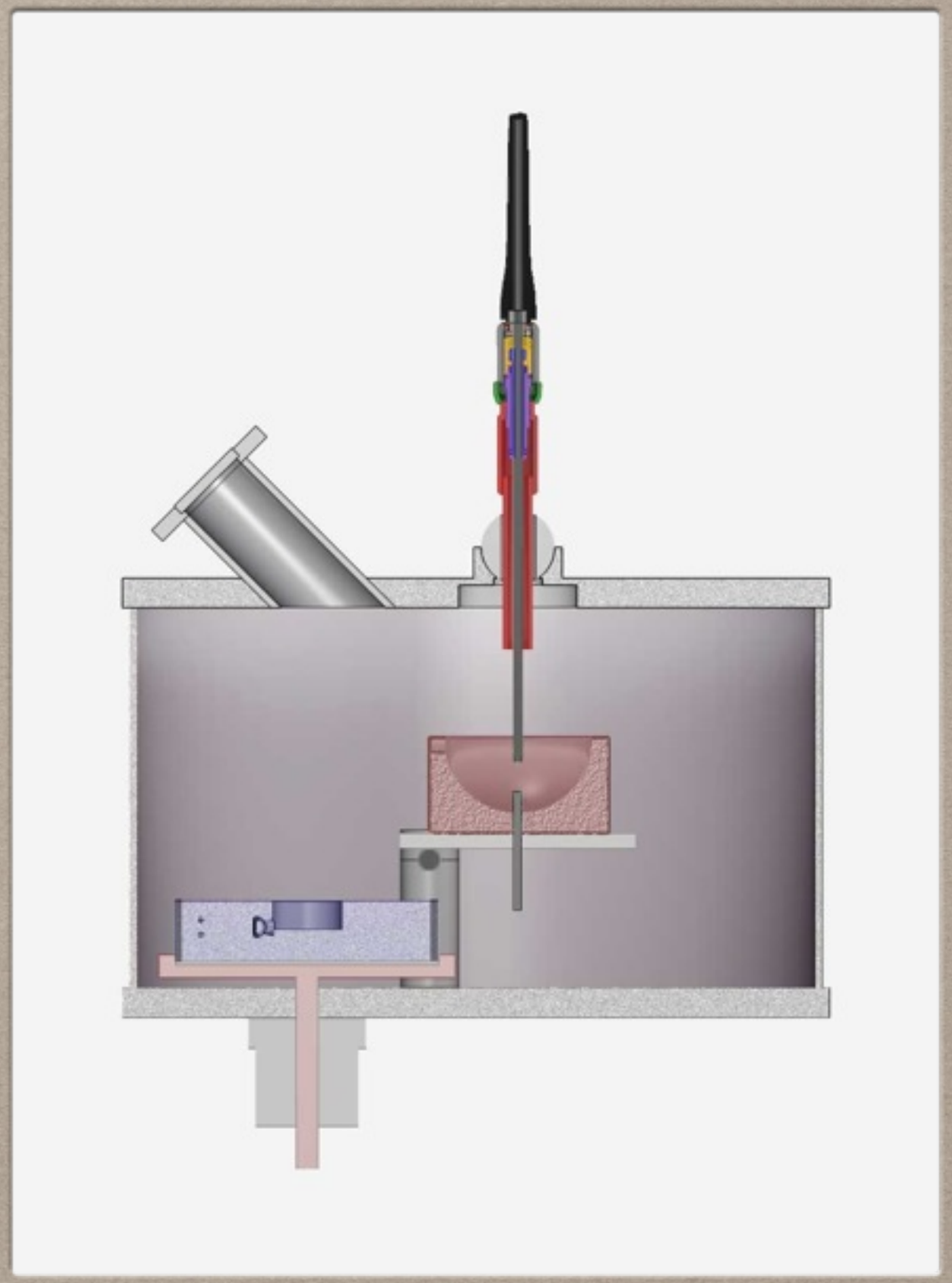
- Chamber purged by flowing a large volume of inert gas to reduce O2 to acceptable level
- Vacuum air lock to move flasks in and out.
- Less stringent materials requirement for box
- Much greater gas usage
- Still have to work through glove ports

HANDHELD MELTING CHAMBER

- Arc version of the typical hand held melting furnace
- Quartz cylinder to shield melt from outside atmosphere during melt
- Some metals would not work as well due to greater oxygen presence during pouring

PURPOSE BUILT SYSTEM

- Variation on lab button melter.
- Motor on outside of chamber
- Small volume of gas to deal with for quick cycle time.
- No gloves



WHAT'S NEXT?

- Additional metals
- Build some different systems
- Melt temperature control

THANK YOU

Eddie Bell

The Santa Fe Symposium Staff

Linus Drogs /Au Enterprises

And special thanks to my wife Terry for all her help and understanding